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GPC Light Shaper for energy efficient laser materials processing

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The biggest use of lasers is in materials processing. In manufacturing, lasers are used for cutting, drilling, marking and other machining processes. Similarly, lasers are important in microfabrication processes such as photolithography, direct laser writing, or ablation. Lasers are advantageous because they do not wear out, have no physical contact with the processed material, avoid heating or warping effects, and are generally more precise. Since lasers are easier to adapt to different optimized shapes, they can be even more precise and energy efficient for materials processing. The cost and complexity of typical laser shaping techniques, however, prevent its wide use. Hence, to benefit from laser shaping, we design energy efficient light shapers based on the Generalized Phase Contrast method (GPC) [1,2]. GPC efficiently shapes incident laser illumination into arbitrary lateral beam profiles with steep, well defined edges that would further increase laser cutting precision or allow “single shot” laser engraving of arbitrary 2D profiles, as opposed to point scanning [3,4]. Instead of lossy approaches, GPC beam shaping is achieved with simplified, binary phase-only optics [5] that redistributes the available photons into the desired output shape, removing upto ~66% from typical power requirements due to a threefold intensity gain. Furthermore, upto ~93% of losses from typical amplitude masking is consistently reclaimed.

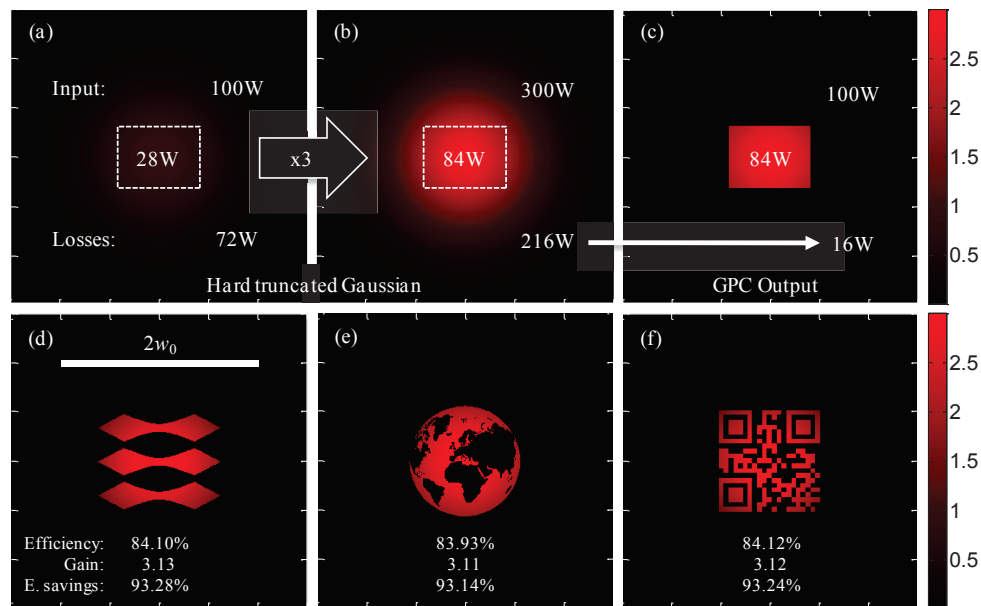


Figure 1. (a)-(c) Comparison of a GPC Light Shaper to a hard truncated Gaussian, delivering 84W on identical rectangular areas. The truncated Gaussian requires 300W and loses 216W as opposed to a GPC Light Shaper which requires only 100W. Upto 93% (200W) of the energy losses in the truncated Gaussian can therefore be saved by a GPC Light Shaper. (d)-(f) Efficiently generated arbitrary 2D intensity profiles showing GPC's potential for single shot laser engraving.

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